

REMARKS

The specification and claims have been amended to include --and the wrapped target components-- following "oil-in-water emulsions". The antecedent basis for this addition can be found on page 9, lines 30-32. Additionally the --wrapped target components-- are implicitly stated on page 1, lines 20-23, page 8, lines 27-34 and page 13, lines 20-23.

The prior art patents cited by the Examiner namely, 5,433,853 (Mamone) and 4,026,794 (Mauceri) have been added to the BACKGROUND ART SECTION.

Claims 1, 2, 4, 7 and 11 have been amended, claim 3 remains as previously submitted and claims 5, 6, 8, 9, 10, 12 and 13 have been cancelled.

Claim 2 was rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point to and distinctly claim the subject matter which applicant regards as the invention. Namely, "such as" was considered vague and indefinite.

Claim 2 has been amended to remove the term "such as". As amended, the claim is now deemed to have overcome the 35 U.S.C. 112 rejection.

Claims 1-6 and 11-13 were rejected under 35 U.S.C. 103(a) as being unpatentable over Mamone 5,433,853 in view of Mauceri 4,026,794.

Claims 5, 6, 12 and 13 have been cancelled, claim 3 remains as originally filed and claims 1, 2, 4, and 11 are respectfully traversed.

Claim 1 has been amended to include the target components wrapped within the oil-in-water emulsions.

Claim 2 has been amended by removing the terms "such as" and "dairy products".

Claim 4 has been amended by incorporating the trivalent compounds listed in claims 5 and 6.

Claim 11 has been amended by incorporating the filtration means listed in claims 12 and 13.

Claims 7-10 were rejected under 35 U.S.C. 103(a) as being unpatentable over Mamone 5,433,853 in view of Mauceri 4,06,8794 as above, and further in view of Gaughan et al.

Claims 8, 9 and 10 have been cancelled and claim 7 is respectfully traversed.

Claim 7 has been amended by incorporating the base compounds listed in claims 8, 9 and 10.

The following argument is applicable to both of the above 35 U.S.C. 103 (a) rejections: the Mamone patent discloses a process for removing emulsified oils, dissolved solids and particulates from a water containing a liquid waste stream. The waste stream is derived from food processing, plating, chemical manufacturing, petroleum production or petroleum

refining. The Mamone process is used for the removal of oil and other solid and particulates from water resulting from an industrial waste stream.

Emulsion in general consists of a mixture of two liquids, such as oil and water. The oil disclosed in Mamone can be easily separated from the liquid waste stream by breaking the emulsion. It is common knowledge that oil and water will separate because they consist of two different phases that do not normally mix. The solids and particulates dissolved in the water can also be easily separated utilizing various precipitation techniques.

The applicant has indicated throughout the application and specifically in amended claim 2 that the emulsion claimed in the application is comprised of positively or negatively charged colloids in pharmaceutical drug products. To further differentiate the applicants claimed emulsion, it is disclosed in the specification that the applicants claimed emulsion is comprised (as amended in claim 1) of target components wrapped within the emulsion. It is critical in the process disclosed by the applicant, to keep the target components within the emulsion by limiting the emulsion from breaking up. A disadvantage of breaking up an emulsion is that some relatively high water soluble compounds, which were originally in the oil particles, may be re-distributed to the water phase resulting in an incomplete treatment that will cause the treated waste water to exceed the pre-imposed discharge limit.

The emulsified oil disclosed in Mamone is clearly different than the oil in water emulsion or colloids specified in the applicant's claims. Mamone is not concerned in emulsion breakage because their purpose is

to separate the oil from the water phase, whereas in the applicant's process, emulsion breakage must be controlled because it is critical to keep the components in the oil particles within the emulsion for a successful process and to achieve treated water within the discharge limit.

Mauceri discloses a method of separating floc produced by trivalent cations from an oily waste water utilizing gravity separation as well as centrifugation and filtration, to remove precipitation. However, the similarity stops there. Again, it should be emphasized that the applicant claims a process for removing oil-in- water emulsion and the wrapped target components within the emulsion by limiting emulsion breakage. Thus, keeping the components originally wrapped in the emulsion from entering the water phase, the importance of which is mentioned throughout the application. The floc produced by trivalent cations from an oily waste water, as disclosed in Mauceri, is obtained by utilizing an emulsion breakage as specifically stated in the Mauceri abstract. This is exactly the opposite from the process claimed by the applicant. In fact, the process as claimed by the applicant would not allow the treated water to meet disposal limits if emulsion breakage cannot be limited.

In regard to applicant's claim 4, Mauceri disclose the use of aluminum sulfate to remove oil from the waste water. The applicant's claim 4 utilizes potassium aluminum sulfate, which is a different substance than the one recited in Mauceri. However, the importance of which does not rely on the type of compound utilized to remove oil nor does the importance lie on the means for separating the precipitate. The important factor that distinguishes the applicant's process, as compared to

Mamone and Mauceri is that the applicant's process needs to be controlled in order to minimize the amount of wrapped target components from being released into the water phase, whereas the process claimed by Mamone and Mauceri breaks up the emulsion in order to separate the oil from the water phase.

In regard to claim 7 Gaughan discloses that it is known in the art to utilize specific base compounds including sodium carbonate, sodium hydroxide and ammonia as an alkaline material, to aid in precipitating metal ions in waste water. This is similar to the ground of rejection in view of Mauceri in regard to claim 4 as discussed above. The use of a base compound to aid precipitation is not new in the art. Any base compound can be utilized for such process as mentioned in the application. However, the applicant in claim 7, states that the base compound is sodium bicarbonate, (which is preferred) and which is a different substance than sodium carbonate referred to in Gaughan. The critical point in the applicant process lies in the step of adding the base compound to produce precipitate. This step needs to be controlled and performed carefully because the emulsion can easily break up during this stage. It is important to note that it is necessary in the applicant process for removing emulsions and the target components wrapped within the emulsions to limit emulsion breakage in order to obtain a successful water treatment that will meet the discharge limit.

The process disclosed by Gaughan is similar to the process claimed in Mamone and Mauceri, in which the object is to remove various contaminants from industrial wastewater and any oil dispersed therein. Emulsion breakage is not of concern simply because

there are no components within the emulsion recited in the reference teachings that are going to be released into the water phase. In fact, Mauceri specifically uses cationic terpolymer as an emulsion breaker in their process to separate the oil phase from the water phase. Mamone also utilizes a similar compound of cationic polymer in their process. Even though Gaughan utilizes a different compound, the objective is similar to the Mamone and Mauceri inventions. The applicant deems that it is not obvious for one to modify the process of Mamone and Mauceri in view of Gaughan simply because the process claimed by the applicant is different in a critical aspect that emulsion breakage is not an option.

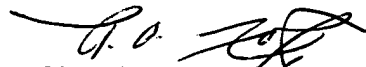
Furthermore there can be no prima facie case of obviousness merely because there is no suggestion in the references or in the knowledge generally available to one of ordinary skill in the art to modify the reference or to combine reference teachings to utilize the applicant's process. The Mamone and Mauceri disclosure do not suggest or mention any type of concern regarding emulsion breakage nor any effort to limit them.

In summary, the emulsified oil and the process disclosed in the instant application and in the reference teachings are deemed to be differ. The process for removing emulsions and the wrapped target components from wastewater as claimed by the applicant would not be successful if performed through any of the referenced teaching.

In view of the above amendments and arguments it is deemed that the Examiner's rejection have been overcome. Therefore the applicant respectfully requests the allowance of claims 1, 2, 3, 4, 7 and 11 at an early date is solicited.

A fee of \$210.00 is enclosed to cover a two-month Extension of Time.

Respectfully submitted,



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A PROCESS FOR REMOVING EMULSIONS AND THE
WRAPPED TARGET COMPONENTS FROM WASTE WATER

TECHNICAL FIELD

The invention pertains to the general field of waste water treatment processes and, more particularly, to a process for removing ~~an~~ oil-in-water emulsions from waste water. The process limits the emulsions from breaking up. Thus, reducing the target components wrapped within the emulsions from being released and entering the water phase.

BACKGROUND ART

An oil-in-water emulsion is a solution consisting of small oil particles that are evenly dispersed in water. The emulsion can be stabilized by adding surfactant compounds, which bridge nonpolar oil and polar oil water phases. One method of treating waste that is created by the emulsion is to break up the emulsion's state using a de-emulsifier. The de-emulsifier utilizes chemicals which separate the oil-in-water emulsion into an oil phase and a water phase, thus allowing both the oil and the water to be recycled.

A disadvantage of breaking up an emulsion is that some relatively high water soluble compounds, which were originally in the oil particles, may be re-distributed to the water phase. Additional treatment is then required if the concentration of the water soluble compounds exceeds a pre-imposed discharge limit.

One example in which waste water is generated is during the manufacturing of propofol injectable. Propofol is chemically described as 2,6-Diisopropylphenol (CAS registration number 2078-54-8) and has been widely used as anesthesia. Propofol injectable is formulated in a white, oil-in-water emulsion. The final concentration of propofol injectable that pharmaceutical companies make is 1%. In addition to the active component propofol, the formulation also contains 10% soybean oil, 2.25% glycerol, 1.2% egg lecithin and 0.005% disodium edetate with sodium hydroxide to adjust pH to 7 - 8.5.

The waste water generated during the manufacturing of propofol injectable contains ~~white~~ white emulsion of propofol, soybean oil, glycerol, egg lecithin and a small amount of disodium edetate. Since propofol is a phenolic compound, and soybean oil belongs to oil waste, their discharge in the United States is regulated by a governmental agency. For many cities in the U.S., the permissible discharge limit for phenolic compounds is 0.5 mg/L, and for oil is 375 mg/L. Since the concentrations of propofol and soybean oil are more than 10,000 times higher than the discharge limits, the waste water generated during pharmaceutical production of propofol injectable requires treatment to remove or reduce propofol and soybean oil from the waste water before being discharged into a sewage system.

Propofol is a very stable phenolic compound. Stress tests have shown no detectable degradation when 3% propofol is refluxed for 2 hours in one in 100 ~~NHCL~~ solution, or refluxed for 2 hours in 7% H_2O_2 solution, or under 3 hours of UV radiation at 254 nm. Therefore, it is difficult to chemically destroy propofol emulsion. If a de-emulsifier is added to the waste, propofol molecules originally wrapped by lecithin will be released into the water phase; thus resulting in a

propofol-saturated water phase that is higher than the discharge limit.

A search of the prior art did not disclose any patents that read directly on the claims of the instant invention, however the following U.S. patents are considered related:

<u>PATENT NO.</u>	<u>INVENTOR</u>	<u>ISSUED</u>
<u>5,433,853</u>	<u>Mamone</u>	<u>18 July 1995</u>
<u>4,160,742</u>	<u>Raman</u>	<u>10 July 1979</u>
<u>4,075,183</u>	<u>Kawakami, et al</u>	<u>21 February 1978</u>
<u>4,026,794</u>	<u>Mauceri</u>	<u>31 May 1977</u>
<u>3,956,117</u>	<u>Bradley, et al</u>	<u>11 May 1976</u>

The 5,433,853 patent discloses the use of an acid, a coagulant, and a flocculent to remove emulsified oils, dissolved solids, and particulates from wastewater. The wastewater is pH adjusted to approximately 6 by an acid. Chemical coagulant (such as ferric chloride, aluminum chloride) is added to remove oil and particulates by means of precipitation. The pH of the water is re-adjusted to about 6 so that the metal hydroxides are dissolved, causing the oil, grease and other constituents to be separated from the liquid phase as a solid. A polymer flocculent is added in the last stage to cause an attraction between the solids allowing them to gather and build mass. A vertical plate pack chamber facilitates the removal of the flocculants.

The 4,160,742 patent discloses the use of copolymers of acrylamide and methylacrylamidopropyltrimethylammonium chloride to de-emulsify oil-in-water emulsions especially in waste streams prior to their discharge from petroleum refineries, industrial plants and the like.

The 4,075,183 patent discloses a water-soluble, cationic high polymer consisting of (A) at least one of acrylamide and methacrylamide and (B) at least one of

ammonium type monomers of either one of the formulas: ##STR1## wherein R.sub.1 is a hydrogen atom or a methyl group, R.sub.2 and R.sub.3 are each a lower alkyl group, R.sub.4 is a hydrogen atom, a lower alkyl group, an aryl group, a hydroxy (lower) alkyl group, a benzyl group or a group of the formulas: CH.sub.2 COO(CH.sub.2).sub.m CH.sub.3 (m being an integer of 0 or 1), R.sub.5.sup.- is a group of either one of the formulas: --(CH.sub.2).sub.2 COO.sup.- and -(CH.sub.2).sub.3 SO.sub.3.sup.-, X is a halogen atom or an acid residue, Y is -O- or --NH-- and n is an integer of 1 to 4, a process which initiates the polymerization of the monomeric component (A) with or without a portion of the monomeric component (B) in an aqueous medium containing an organic solvent selected from the group consisting of acetone, acetonitrile, t-butanol, tetrahydrofuran and dioxane at a concentration of about 15 to 70% by weight until the polymerization proceeds to a certain extent and then continuing the polymerization while adding the remaining portion of the monomeric component (B) thereto under the occasional supplementation of a water-miscible organic solvent thereto so as to keep an appropriate viscosity of the reaction system to produce the high polymer in a high yield with ease.

The 4,026,794 patent discloses the use of a water soluble amphoteric metal, such as MgCl₂ and ZnCl₂, and a water soluble cationic terpolymer to break the negatively charged oil-in-water emulsion to form an easily recoverable floc containing oil particulates from the wastewater.

The 3,956,117 patent discloses a method of breaking oil-in-water emulsions involving treating such oil-in-water emulsions with a polycationic water-soluble condensation copolymer. Treatment with the copolymer transforms the emulsified oil particles

into flocs which may be directly removed or which may be removed after the addition of one or more flocculants.

The above prior art patents address separation and removal of oil, greases and particulates in the oil-in-water emulsions. However, these patents were not designed to keep the components originally wrapped in the emulsion from entering the water phase. Such a need is often found in pharmaceutical products where the active pharmaceutical ingredient(s) inside the oil-in-water emulsion is often much more toxic than the oil phase. A wastewater treatment process must, therefore, not only separate the oil but also separate the compounds inside the emulsion from the water phase.

DISCLOSURE OF THE INVENTION

A process for removing ~~an~~ oil-in-water emulsions and the target components wrapped within the emulsions from waste water that results from the production of a water-based product, the process comprising the following steps:

- a) collect the emulsion waste water in a container,
- b) add a quantity of a precipitation reagent with trivalent cations, and
- c) add a quantity of a base compound to adjust the pH of the waste water to approximately 6.5, which converts the dissolved trivalent cations to gelatinous cation hydroxide precipitation and separates the emulsion and the target components from the waste water, and

d) separate the precipitation from the waste water by utilizing a filtration means.

To refine the above process, the precipitation can be separated from the waste water by utilizing a filtration means. The filtration means can consist of several processes including: vacuum filtration, positive pressure filtration, or by using a centrifuge.

By using the above process, the level of an emulsion can be reduced from 1000 ppm or above to less than 1 ppm. In addition, target components wrapped in the emulsion remain in the flocs, which allows the treated water to meet the disposal limits.

In view of the above disclosure, the primary object of the invention is to provide a process by which waste water containing an oil-in-water emulsion may be treated to remove the emulsion, along with the components inside the emulsion thus allowing proper disposal of the waste water.

It is also an object of the invention to:

- o provide a waste water treatment process that can be utilized to treat different types of substances containing an oil-in-water emulsion,
- o provide a waste water treatment method that is quickly and easily performed,
- o allow the amounts of certain chemicals within waste water to be determined, and
- o provide a process by which a person/corporation who manufacture products having waste water can dispose of the waste water according to government-specified levels.

These and other objects and advantages of the present invention will become apparent from the subsequent detailed description of the preferred embodiment and the appended claims. ~~taken in conjunction with the accompanying drawings.~~

BEST MODE FOR CARRYING OUT THE INVENTION

The best mode for carrying out the invention is presented in terms of a preferred embodiment for preparing (treating) waste water containing oil-in-water emulsion for disposal. The amount of oil-in-water emulsion that can be discharged during disposal without treatment is regulated by most United States city's municipal water districts. Typically, the permissible discharge limit for a phenolic compound is 0.5 mg/L, and for oil it is 375 mg/L. Since the concentrations of certain products, such as Propofol injectable and soybean oil, are more than 10,000 times higher than the discharge limits allowed, the waste water created during manufacture must be treated prior to disposal.

In order to treat the waste water/emulsion solution, (hereinafter "WWES"), the instant invention utilizes an aluminum hydroxide co-precipitation method. In this method a specified amount of a precipitation reagent having trivalent compounds, such as potassium aluminum sulfate ($KAl(SO_4)_2$), aluminum chloride or ferric chloride is added along with a determined amount of a base compound, such as sodium bicarbonate ($NaHCO_3$), sodium carbonate, ammonia or sodium hydroxide. The base compound is used to adjust the pH level, precipitation is generated within the WWES. (Note: for the purpose of this description, the precipitation reagent having trivalent compounds will be referred to throughout the text as potassium aluminum sulfate). The precipitation then brings down suspended oily particles (the "emulsion") and limit the emulsion from breaking up. Thus, molecules that were originally wrapped in the oily particles are retained in the sediments, rather than distributed between oil and water phases according to their solubilities in

both phases.

In order to use the invention, the following process is utilized:

A specified amount of potassium aluminum sulfate ($KAl(SO_4)_2$) is added to a container having an amount of WWES within. The potassium aluminum sulfate changes the pH of the WWES from neutral to about 3.5. The pH is then adjusted to approximately 6.5 by adding the base compound. As the pH increases, dissolved aluminum ions hydrolyse to form gelatinous aluminum hydroxide ($Al(OH)_3$) precipitate. The gelatinous aluminum hydroxide ($Al(OH)_3$) precipitate slowly settles to the bottom of the container, taking the suspended emulsions and the wrapped target components with it, thus creating a clear water phase and a settlement phase. The clear water is then separated from the settlement by a filtration means, that can consist of vacuum filtration, positive pressure filtration, a centrifuge, or by utilizing a filter paper, such as a No. 6 Whatman filter paper. In order to facilitate a complete phase separation in certain products, an activated carbon layer is used with the filter paper which is typically comprised of a #6 Whatman paper.

In order to disclose a complete description and the use of the invention, the following examples are given:

Example #1, treatment of 1% Propofol injectable

Example #2, treatment of diluted Propofol injectable,

Results of Examples #1 and #2

Example #3, regular Milk

Example #4, reduced fat milk

Example #5, fat free milk

Example #6, soy milk

Example #7, Ensure^(R) nutritional drink produced by Ross Products Division, Abbott Laboratories, Columbus, OH, 43215

The instant invention is designed to treat emulsion waste waters in examples 1 and 2 where separation of oil as well as propofol is required. It is important to limit emulsions from breaking up so the wrapped target components remain in the emulsions to allow separation, instead of entering the water phase. Examples 3 - 7 are demonstrations that this invention is also applicable to other matrices.

Example 1. Treatment of 1% Propofol Injectable

To a solution of 1% Propofol injectable, add 5% (by weight) of potassium aluminum sulfate, hereinafter $KAl(SO_4)_2$. For example, 5 grams of $KAl(SO_4)_2$ should be added to 100 grams of 1% Propofol injectable solution. Once the $KAl(SO_4)_2$ has been completely dissolved, the pH of the solution will be approximately 3.5.

While stirring the solution, slowly add solid sodium bicarbonate ($NaHCO_3$) until the pH rises to 6.5. The amount of sodium bicarbonate needed to achieve the designated pH is about 3 - 5% weight of the solution. Since sodium bicarbonate is a weak base, the pH of the solution won't be greater than 7, even if more than 5% of sodium bicarbonate is used.

As the pH of the solution increases, the dissolved aluminum ions (Al^{+3}) start to precipitate as a form of glutinous aluminum hydroxide ($Al(OH)_3$). The aluminum hydroxide also absorbs the emulsion in the solution while precipitating, thus resulting in phase separation of clear water at the top and white precipitation at the bottom. It should be noted that due to the generation of carbon dioxide, the precipitation first is on the top layer. If it is left standing overnight, all precipitation will be settled at the bottom layer.

The addition of sodium bicarbonate generates carbon dioxide bubbles, and care should be taken to add sodium

free milk of 6,2000 NTU, the turbidity reduction by this treatment is 12,000 times.

Example 6. Soy milk

To a solution of 100 mL soy milk (Tan Nam), 2.5 gram of $KAl(SO_4)_2$ is added. The resulting pH of the solution is 3.75. Slowly add 1.5 gram of $NaHCO_3$ while stirring; phase separation starts when the aluminum hydroxide starts to precipitate. The resulting precipitates are then filtered through a No. 6 filter paper. The Turbidity of the final filtrate is 1.4 NTU. About 30 grams of solids remained on the filter paper. The turbidity of original soybean milk is 29,000 NTU, thus Turbidity is reduced by 20,000 times.

EPA method 413.2 is used to measure oil and grease level. The oil and grease level in the soy milk is 43,000 mg/L. After treatment, oil and grease level is reduced to 10 mg/L.

Example 7. Ensure^(R) Nutritional drink

Prepare a starting solution by adding 10 gram of the Ensure^(R) nutrition drink into 90 mL of water. Add 2 grams of $KAl(SO_4)_2$, the resulting pH is 3.56. Slowly add 1.5 grams of $NaHCO_3$ while stirring; phase separation starts when the aluminum hydroxide starts to precipitate. The resulting precipitates are then filtered through a No. 6 filter paper. The Turbidity of the final filtrate is 0.27 NTU. Compared with the Turbidity of 10 times diluted ensure solution of 99,500 NTU, the turbidity reduction by this treatment is 300,000 times.

Zeta potential analysis

ABSTRACT OF THE DISCLOSURE

A process for removing ~~an~~ oil-in-water emulsion and the wrapped target components from waste water. The process consists of collecting the emulsion waste water, adding a precipitation reagent with trivalent cations, and adding a base compound to adjust the pH of the waste water. The adjusted waste water converts the dissolved trivalent cations to gelatinous cation hydroxide precipitations and separates the emulsion along with the wrapped target components from the waste water. The process can be enhanced by also utilizing a filtration means to further separate the precipitation from the waste water. The process is designed to reduce the level of the emulsion from 1000 ppm to less than 1 ppm.